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Kelbie et al.

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(54) **PUMP DOWN ISOLATION PLUG**

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E21B 23/08 (2006.01)

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CPC ***E21B 33/127*** (2013.01); ***E21B 23/08*** (2013.01); ***E21B 37/02*** (2013.01)

(58) **Field of Classification Search**
CPC E21B 33/127–1277; E21B 33/1295
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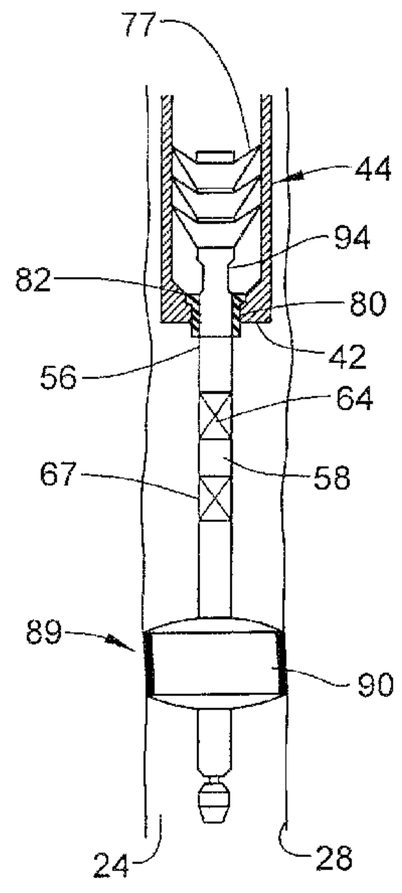
(57) **ABSTRACT**

An isolation plug including a support element having a first end, a second end, and an intermediate portion extending therebetween. At least one flexible wiper element is arranged at the first end. A frangible locator element is arranged at the first end spaced from the at least one flexible wiper element. A selectively deployable plug element is arranged at the second end.

15 Claims, 4 Drawing Sheets



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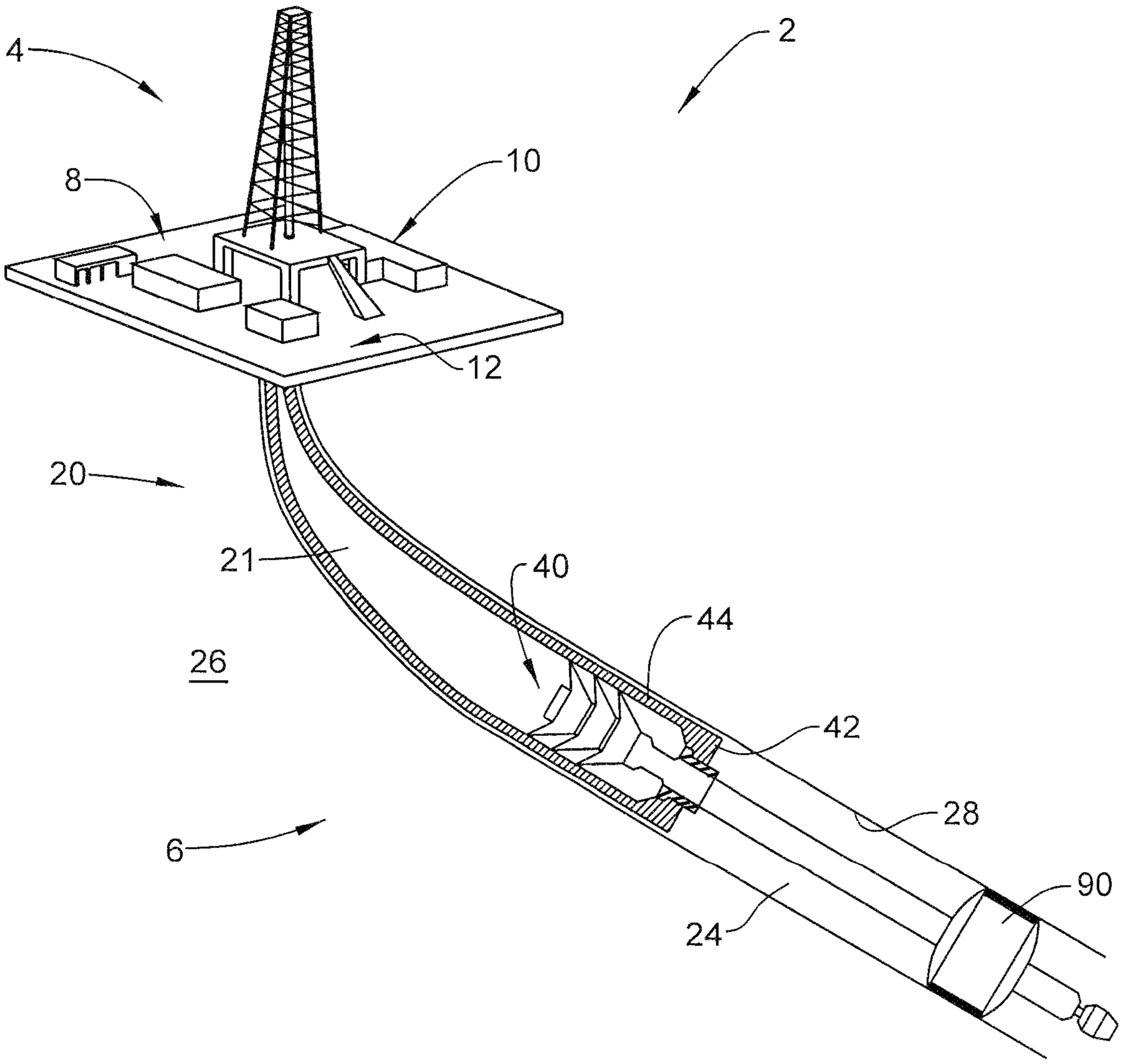

FIG. 1

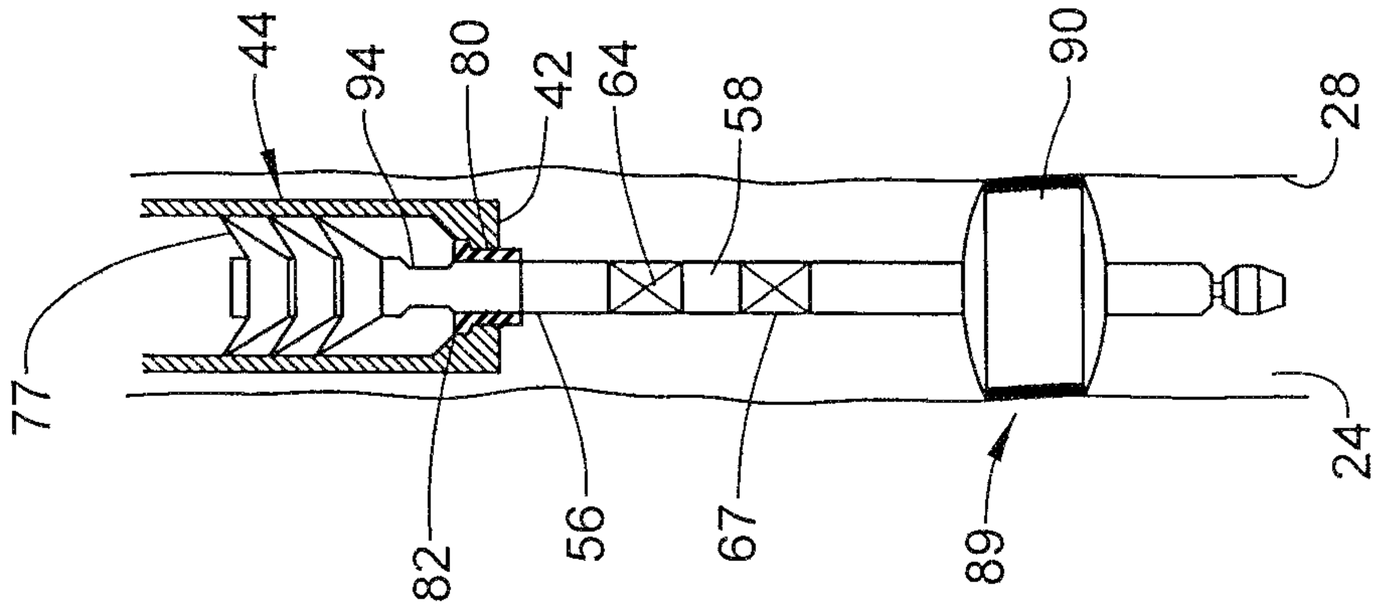

FIG. 4

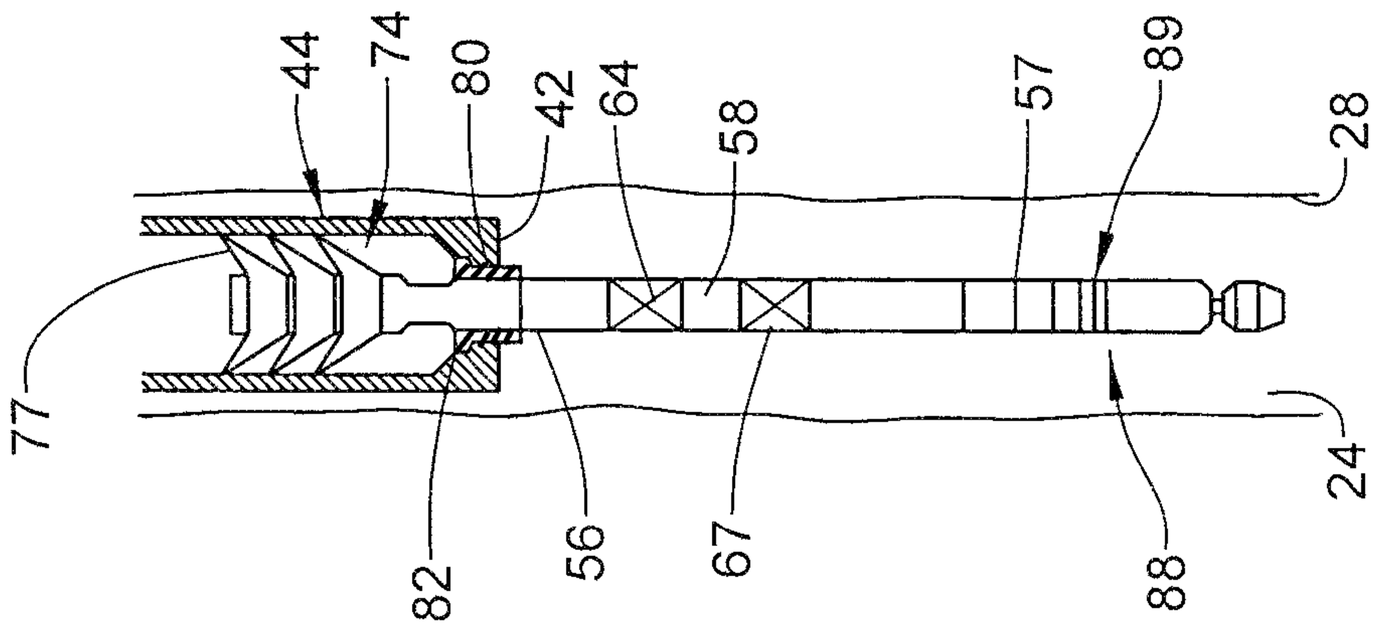

FIG. 3

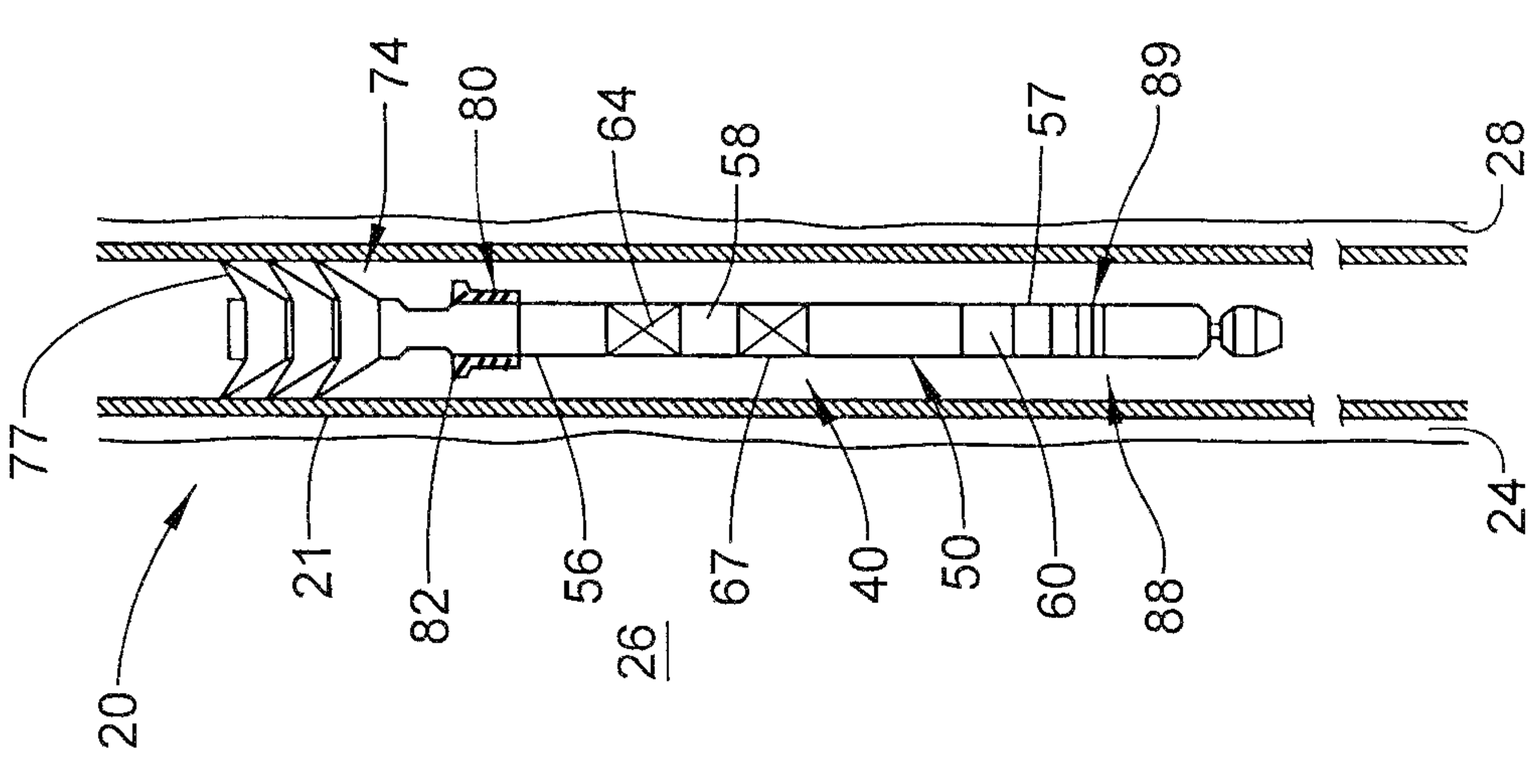

FIG. 2

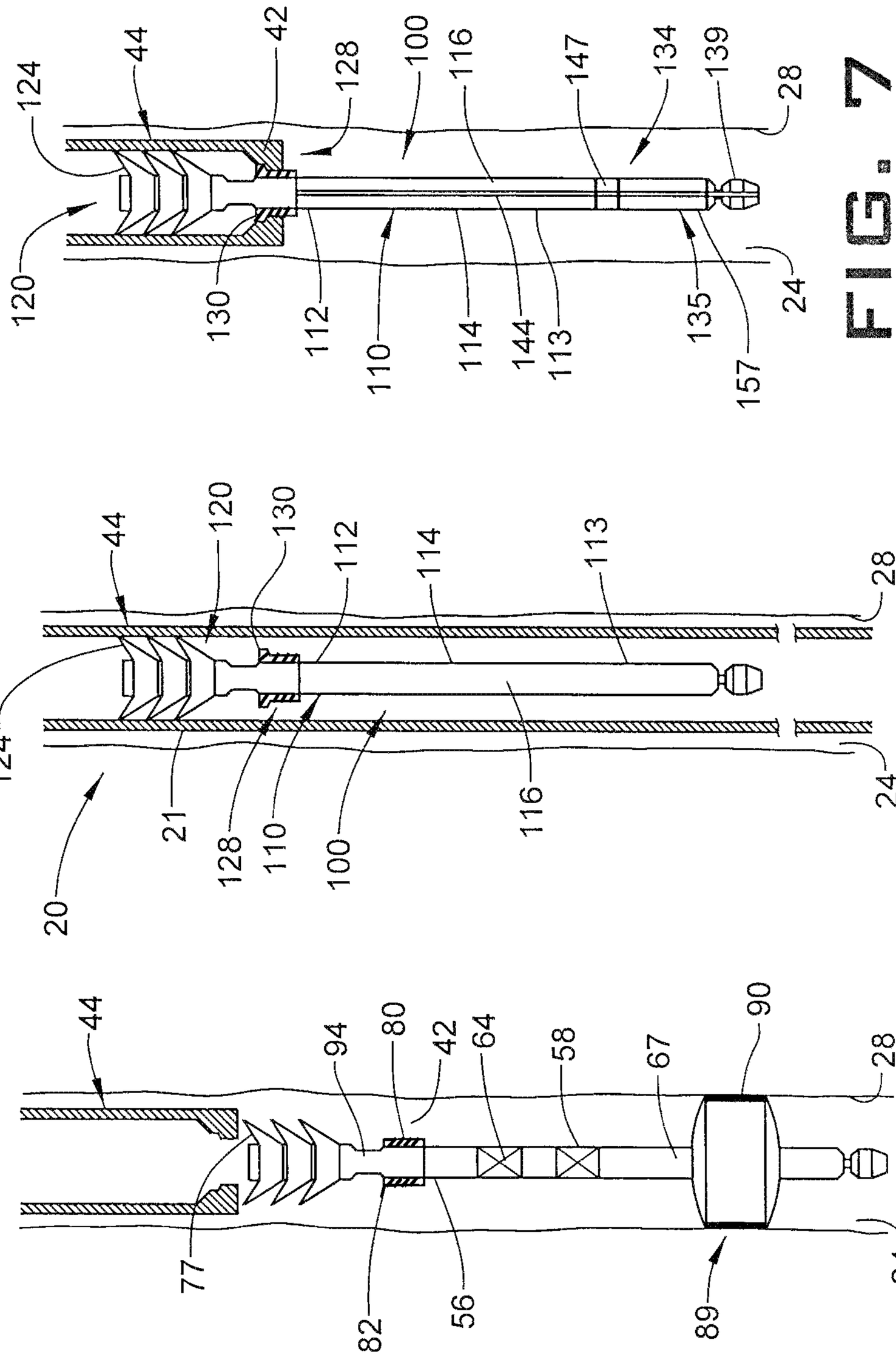

FIG. 7

FIG. 6

FIG. 5

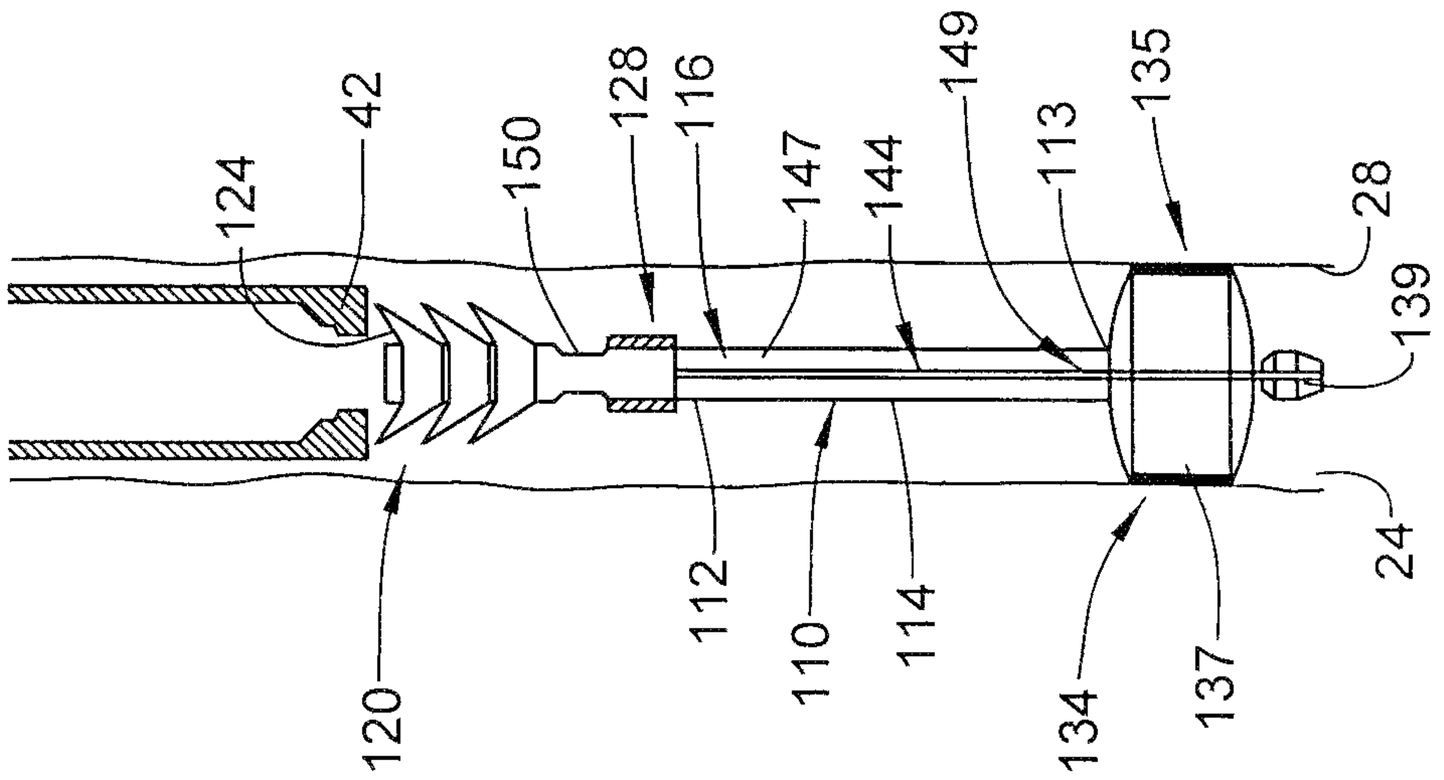
124
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FIG. 9

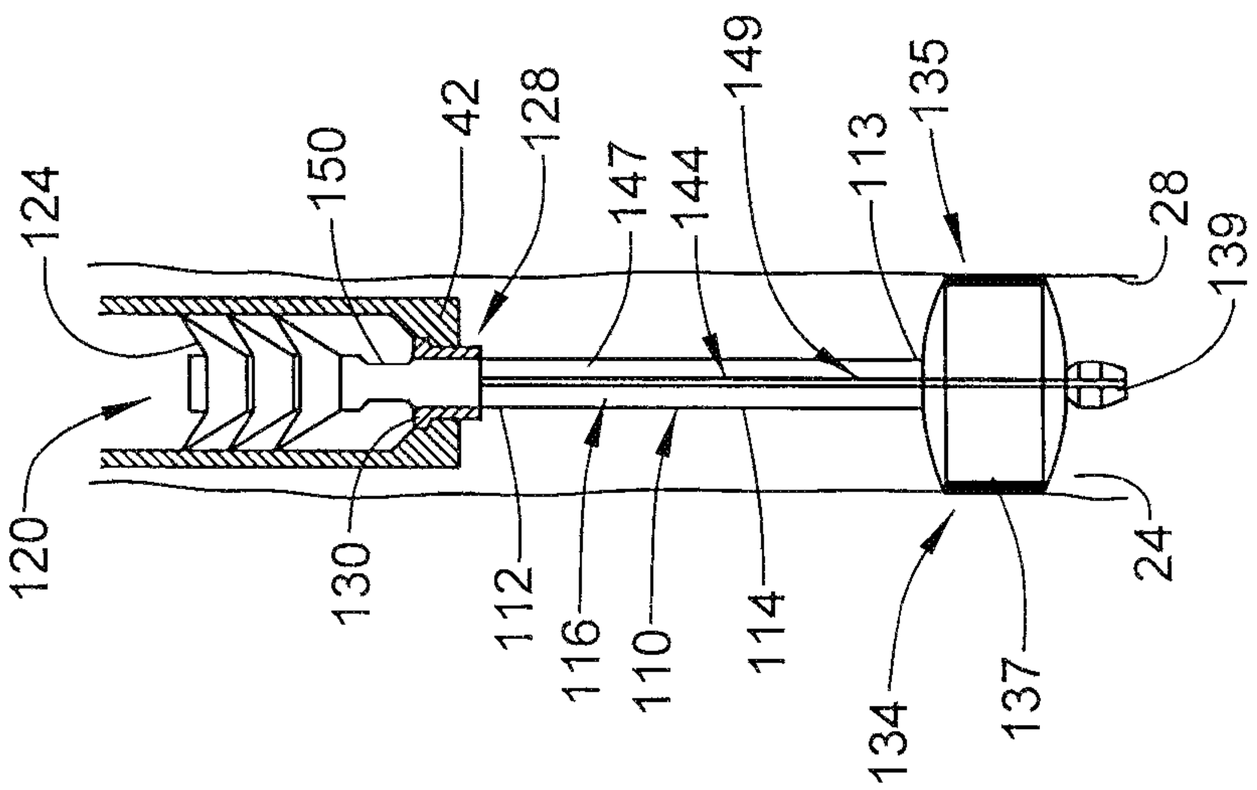
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FIG. 8

PUMP DOWN ISOLATION PLUG

BACKGROUND

In the drilling and completion industry, it is often desirable to close off a well bore for a period of time. For example, it is desirable to close a wellbore prior to abandonment. To close a wellbore, one or more plugs are inserted to a desired depth(s). After inserting the plugs, cement or other filler material may be introduced into the well bore. If it is desirable to reopen the wellbore, the cement and plug(s) may be removed by, for example, drilling. A plug may be run through a system of tubulars to a desired position in the wellbore. The plug is typically connected to connect to a deployment string and introduced into the wellbore. The deployment string could take the form of coil tubing, wireline, or slickline tools.

Running a deployment tool into a wellbore is a time consuming labor intensive process, as it the removal of the deployment tool after plug installation. Further, if setting multiple plugs, the deployment tool must be run in and removed multiple times. Accordingly, the art would be receptive to a system of installing and setting plugs that did not require a deployment tool.

SUMMARY

Disclosed is an isolation plug including a support element having a first end, a second end, and an intermediate portion extending therebetween. At least one flexible wiper element is arranged at the first end. A frangible locator element is arranged at the first end spaced from the at least one flexible wiper element. A selectively deployable plug element is arranged at the second end.

Also disclosed is a resource exploration and recovery system includes a first system and a second system fluidically connected to the first system. The second system includes a string of tubulars. At least one of the string of tubulars includes a locator grapple. An isolation plug is selectively arranged within the string of tubulars. The isolation plug includes a support element having a first end, a second end, and an intermediate portion extending therebetween. At least one flexible wiper element is arranged at the first end. A frangible locator element is arranged at the first end spaced from the at least one flexible wiper element. The frangible locator element is selectively engaged with the locator grapple. A selectively deployable plug element is arranged at the second end.

Further disclosed is a method of plugging a wellbore includes pumping an isolation plug along a string of tubulars, engaging a frangible locator element on the isolation plug with a locator grapple arranged on the string of tubulars, expanding a plug portion of the isolation plug, and detaching the frangible locator element from the locator grapple.

BRIEF DESCRIPTION OF THE DRAWINGS

The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

FIG. **1** depicts a resource exploration and recovery system including an isolation plug, in accordance with an aspect of an exemplary embodiment;

FIG. **2** depicts the isolation plug arranged in a tubular string of the resource exploration and recovery system, in accordance with an aspect of an exemplary embodiment;

FIG. **3** depicts the isolation plug landing at a locating grapple on one tubular of the tubular string of FIG. **2**, in accordance with an aspect of an exemplary embodiment;

FIG. **4** depicts the isolation plug of FIG. **3** being expanded, in accordance with an aspect of an exemplary embodiment;

FIG. **5** depicts the tubular string detaching from the isolation plug of FIG. **4**, in accordance with an aspect of an exemplary embodiment;

FIG. **6** depicts an isolation plug arranged in a tubular string of the resource exploration and recovery system, in accordance with another aspect of an exemplary embodiment;

FIG. **7** depicts the isolation plug of FIG. **6** landing at the locating grapple, in accordance with an aspect of an exemplary embodiment;

FIG. **8** depicts the isolation plug of FIG. **6** being expanded, in accordance with an aspect of an exemplary embodiment; and

FIG. **9** depicts the tubular string detaching from the isolation plug of FIG. **8**, in accordance with an aspect of an exemplary embodiment.

DETAILED DESCRIPTION

A detailed description of one or more embodiments of the disclosed apparatus and method are presented herein by way of exemplification and not limitation with reference to the Figures.

A resource exploration and recovery system, in accordance with an exemplary embodiment, is indicated generally at **2**, in FIG. **1**. Resource exploration and recovery system **2** should be understood to include well drilling operations, resource extraction and recovery, CO_2 sequestration, and the like. Resource exploration and recovery system **2** may include a first system **4** which, in some environments, may take the form of a surface system operatively and fluidically connected to a second system **6** which, in some environments, may take the form of a downhole system. First system **4** may include pumps **8** that aid in completion and/or extraction processes as well as fluid storage **10**. Fluid storage **10** may contain a stimulation fluid which may be introduced into downhole system **6**. First system **4** may also include a control system **12** that may monitor and/or activate one or more downhole operations.

Second system **6** may include a tubular string **20** formed from a plurality of tubulars, one of which is indicated at **21** that is extended into a wellbore **24** formed in formation **26**. Wellbore **24** includes an annular wall **28**. An isolation plug **40** may be pumped down tubular string **20**. Isolation plug **40** may be landed at a locating grapple **42** arranged at a terminal tubular **44** of plurality of tubulars **20**. As will be detailed herein, isolation plug **40** may be activated to seal against annular wall **28** isolating one portion of wellbore **24** from another.

Referring to FIGS. **2-5** and with continued reference to FIG. **1**, isolation plug **40** includes a support element **50** having a first end **56**, a second end **57** and an intermediate portion **58** extending therebetween. A passage **60** extends through support element **50** from first end **56** through second end **57**. Passage **60** may support a valve **64** and a baffle element **67**. A wiper dart **74** is arranged at first end **56**. Wiper dart **74** includes one or more flexible wiper elements **77** that engage with an inner wall (not separately labeled) of tubulars **21**. Wiper elements **77** form a seal that promotes pumping isolation plug **40** towards terminal tubular **44**.

In accordance with an exemplary aspect, isolation plug **40** also includes a frangible locator element **80** arranged at first end **56**. Frangible locator element **80** includes a lip **82** that selectively engages with locating grapple **42** to position isolation plug **40** at a selected position in wellbore **24** as shown in FIG. **3**. Isolation plug **40** is further shown to include a selectively deployable plug element **88** having a flexible plug member **89** including an outer surface **90** that is selectively urged against annular wall **28** of wellbore **24**. Flexible plug member may be formed from a variety of elastomeric materials. Flexible plug member **89** may also include swellable components (not separately labeled) that promote additional expansion of selectively deployable plug element **88**.

In further accordance with an exemplary aspect, a fluid may be introduced into tubulars **21** and pumped down to isolation plug **40**. The fluid may enter first end **56** of support element **50** and flow into passage **60**. Valve **64** may be opened to allow the fluid to pass through baffle element **67**. Baffle element **67** controls a flow rate of the fluid passing towards selectively deployable plug element **88**. The fluid inflates or expands selectively deployable plug element **88** toward annular wall **28** as shown in FIG. **4**.

When a selected seal has been established between outer surface **90** and annular wall **28**, valve **64** may be closed and tubular string **20** shifted, causing frangible locator element **80** to disengage from locating grapple **42** as shown in FIG. **5**. For example, frangible locator element **80** may radially compress into a recess **94** or lip **82** may disengage or fail. At this point, tubular string **20** may be repositioned and another isolation plug (not shown) installed, or cement may be introduced into wellbore **24** and tubular string **20** may be removed.

Reference will now follow to FIGS. **6-7** in describing an isolation plug **100** in accordance with an exemplary embodiment. Isolation plug **40** includes a support element **110** having a first end **112**, a second end **113** and an intermediate portion **114** extending therebetween. A passage **116** extends through support element **110** from first end **112** through second end **113**. A wiper dart **120** is arranged at first end **112**. Wiper dart **120** includes one or more flexible wiper elements **124** that engage with an inner wall (not separately labeled) of tubulars **21**. Flexible wiper elements **124** form a seal that promotes pumping isolation plug **100** towards terminal tubular **44**.

In accordance with an exemplary aspect, isolation plug **100** also includes a frangible locator element **128** arranged at first end **112**. Frangible locator element **128** includes a lip **130** that selectively engages with locating grapple **42** to position isolation plug **100** at a selected position in wellbore **24** as shown in FIG. **7**. Isolation plug **100** is further shown to include a selectively deployable plug element **134** having a flexible plug member **135** including an outer surface **137** that is selectively urged against annular wall **28** of wellbore **24** and a terminal end **139**. Flexible plug member **135** may be formed from a variety of elastomeric materials. Flexible plug member **135** may also include swellable components (not separately labeled) that promote additional expansion of selectively deployable plug element **134**.

In further accordance with an exemplary aspect, an actuation rod **144** extends through passage **116** and connects with terminal end **139** of flexible plug member **135**. Actuation rod **144** supports a piston **147** that defines a chamber **149**. Chamber **149** exists between piston **147** and second end **113**. In this manner, a fluid may be introduced into tubulars **21** and pumped down to isolation plug **100**. The fluid may enter first end **112** of support element **110** and flow into passage **116**. The fluid may then pass into chamber **149**. Fluid pressure may be increased causing piston **147** to transition from second end **113** toward first end **112** as shown in FIG. **8**. The movement of piston **147** causes actuation rod **144** to act upon or contract terminal end **139** towards second end **113**. The movement of actuation rod **144** deploys flexible plug element **135**.

When a selected seal has been established between outer surface **137** and annular wall **28**, tubular string **20** shifts, causing frangible locator element **128** to disengage from locating grapple **42** as shown in FIG. **9**. For example, frangible locator element **128** may radially compress into a recess **150**, or lip **130** may disengage or fail. At this point, tubular string **20** may be repositioned and another isolation plug (not shown) installed, or cement may be introduced into wellbore **24** and tubular string **20** may be removed. Thus, it should be understood that the exemplary embodiments describe an isolation plug that may be introduced into a wellbore through existing tubulars, positioned, activated and left in place without the need for additional tooling. The isolation plug may be installed prior to abandonment of the wellbore. For example, the isolation plug may be installed through an existing completion string or may be installed after removal of a completion. Further, it should be understood that the isolation plug may be employed as a zonal isolation device or for other purposes when it may be desirable to close off all or a portion of a wellbore for a period of time.

Set forth below are some embodiments of the foregoing disclosure:

Embodiment 1: An isolation plug comprising a support element including a first end, a second end, and an intermediate portion extending therebetween, at least one flexible wiper element arranged at the first end, a frangible locator element arranged at the first end spaced from the at least one flexible wiper element; and a selectively deployable plug element arranged at the second end.

Embodiment 2: The isolation plug according to any prior embodiment, wherein the support element includes a passage extending from the first end toward the second end, the selectively deployable plug element being selectively expanded by a fluid pumped into the passage.

Embodiment 3: The isolation plug according to any prior embodiment, further comprising a valve arranged in the support element, the valve controlling a fluid flow into the selectively deployable plug element.

Embodiment 4: The isolation plug according to any prior embodiment, further comprising a baffle element arranged in the support element, the baffle element controlling a flow rate of fluid into the selectively deployable plug element.

Embodiment 5: The isolation plug according to any prior embodiment, further comprising an actuation rod extending through the support element and connecting with the selectively deployable plug element.

Embodiment 6: The isolation plug according to any prior embodiment, further comprising a piston mechanically connected with the actuation rod.

Embodiment 7: A resource exploration and recovery system comprising a first system, a second system fluidically connected to the first system, the second system including a string of tubulars, at least one of the string of tubulars including a locator grapple, and an isolation plug selectively arranged within the string of tubulars, the isolation plug comprising a support element including a first end, a second end, and an intermediate portion extending therebetween, at least one flexible wiper element arranged at the first end, a frangible locator element arranged at the first end spaced

from the at least one flexible wiper element, the frangible locator element being selectively engaged with the locator grapple, and a selectively deployable plug element arranged at the second end.

Embodiment 8: The resource exploration and recovery system according to any prior embodiment, wherein the support element includes a passage extending from the first end toward the second end, the selectively deployable plug element being selectively expanded by a fluid pumped into the passage.

Embodiment 9: The resource exploration and recovery system according to any prior embodiment, further comprising a valve arranged in the support element, the valve controlling a fluid flow into the selectively deployable plug element.

Embodiment 10: The resource exploration and recovery system according to any prior embodiment, further comprising a baffle element arranged in the support element, the baffle element controlling a flow rate of fluid into the selectively deployable plug element.

Embodiment 11: The resource exploration and recovery system according to any prior embodiment, further comprising an actuation rod extending through the support element and connecting with the selectively deployable plug element.

Embodiment 12: The resource exploration and recovery system according to any prior embodiment, further comprising a piston mechanically connected with the actuation rod.

Embodiment 13: A method of plugging a wellbore comprising pumping an isolation plug along a string of tubulars, engaging a frangible locator element on the isolation plug with a locator grapple arranged on the string of tubulars, expanding a plug portion of the isolation plug, and detaching the frangible locator element from the locator grapple.

Embodiment 14: The method of any prior embodiment, wherein expanding the plug portion includes directing a flow of fluid into the plug portion.

Embodiment 15: The method of any prior embodiment, wherein expanding the plug portion includes drawing a portion of the plug portion toward the frangible locator.

The use of the terms "a" and "an" and "the" and similar referents in the context of describing the invention (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. Further, it should further be noted that the terms "first," "second," and the like herein do not denote any order, quantity, or importance, but rather are used to distinguish one element from another. The modifier "about" used in connection with a quantity is inclusive of the stated value and has the meaning dictated by the context (e.g., it includes the degree of error associated with measurement of the particular quantity).

The teachings of the present disclosure may be used in a variety of well operations. These operations may involve using one or more treatment agents to treat a formation, the fluids resident in a formation, a wellbore, and/or equipment in the wellbore, such as production tubing. The treatment agents may be in the form of liquids, gases, solids, semi-solids, and mixtures thereof. Illustrative treatment agents include, but are not limited to, fracturing fluids, acids, steam, water, brine, anti-corrosion agents, cement, permeability modifiers, drilling muds, emulsifiers, demulsifiers, tracers, flow improvers etc. Illustrative well operations include, but are not limited to, hydraulic fracturing, stimulation, tracer injection, cleaning, acidizing, steam injection, water flooding, cementing, etc.

While the invention has been described with reference to an exemplary embodiment or embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the claims. Also, in the drawings and the description, there have been disclosed exemplary embodiments of the invention and, although specific terms may have been employed, they are unless otherwise stated used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention therefore not being so limited.

What is claimed is:

1. An isolation plug comprising:

a support element including a first end, a second end, and an intermediate portion extending therebetween;

at least one flexible wiper element extending axially off of the first end;

a frangible locator element arranged on the support element at the first end adjacent to the at least one flexible wiper element, the frangible locator element being a one-piece component including a frangible lip; and

a selectively deployable plug element arranged at the second end.

2. The isolation plug according to claim **1**, wherein the support element includes a passage extending from the first end toward the second end, the selectively deployable plug element being selectively expanded by a fluid pumped into the passage.

3. The isolation plug according to claim **2**, further comprising: a valve arranged in the support element, the valve controlling a fluid flow into the selectively deployable plug element.

4. The isolation plug according to claim **3**, further comprising: a baffle element arranged in the support element, the baffle element controlling a flow rate of fluid into the selectively deployable plug element.

5. The isolation plug according to claim **1**, further comprising an actuation rod extending through the support element and connecting with the selectively deployable plug element.

6. The isolation plug according to claim **5**, further comprising: a piston mechanically connected with the actuation rod.

7. A resource exploration and recovery system comprising:

a first system;

a second system fluidically connected to the first system, the second system including a string of tubulars, at least one of the string of tubulars including a locator grapple; and

an isolation plug selectively arranged within the string of tubulars, the isolation plug comprising:

a support element including a first end, a second end, and an intermediate portion extending therebetween;

at least one flexible wiper element extending axially off of the first end;

a frangible locator element arranged on the support element at the first end adjacent to the at least one flexible wiper element, the frangible locator element being a one-piece component including a frangible lip that is selectively engaged with the locator grapple; and

a selectively deployable plug element arranged at the second end.

8. The resource exploration and recovery system according to claim **7**, wherein the support element includes a passage extending from the first end toward the second end, the selectively deployable plug element being selectively expanded by a fluid pumped into the passage.

9. The resource exploration and recovery system according to claim **8**, further comprising: a valve arranged in the support element, the valve controlling a fluid flow into the selectively deployable plug element.

10. The resource exploration and recovery system according to claim **9**, further comprising: a baffle element arranged in the support element, the baffle element controlling a flow rate of fluid into the selectively deployable plug element.

11. The resource exploration and recovery system according to claim **7**, further comprising an actuation rod extending through the support element and connecting with the selectively deployable plug element.

12. The resource exploration and recovery system according to claim **11**, further comprising: a piston mechanically connected with the actuation rod.

13. A method of plugging a wellbore comprising:

pumping an isolation plug including a support element having a first end and an opposing second end along a string of tubulars by engaging at least one flexible wiper arranged at the first end with a fluid;

engaging a one-piece frangible locator element including a frangible lip arranged at the first end adjacent to the least one flexible wiper with a locator grapple arranged on the string of tubulars;

expanding a plug portion of the isolation plug arranged at the opposing second end of the support element; and

shifting the string of tubulars causing the frangible lip to fail thereby detaching the isolation plug from the locator grapple.

14. The method of claim **13**, wherein expanding the plug portion includes directing a flow of fluid into the plug portion.

15. The method of claim **13**, wherein expanding the plug portion includes drawing a portion of the plug portion toward the frangible locator element.

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